REMARKS

Overview of the Office Action

Claims 16-21, 23, 24, 26 and 28 have been rejected under 35 U.S.C. §102(b) as anticipated by U.S. Patent No. 6,440,810 ("Johansson").

Claims 22, 25, 27 and 29 have been rejected under 35 U.S.C. §103(a) as unpatentable over Johansson in view of U.S. Patent No. 6,028,345 ("Johnson").

Status of the claims

Claims 1-15 have been previously canceled.

Claims 16-29 remain pending.

Interview Summary

Applicants' agent conducted a telephone interview on July 7, 2009 to discuss the rejections described in the outstanding Final Office Action.

Applicants' agent pointed out that according to claim 16, BF_2 is introduced as a dopant of a first conductivity type into the dielectric layer after the application of the mask R. In contrast, Johansson teaches that the BF_2 is introduced into the α-Si layer before the application of any mask, as shown in Fig. 4 of Johansson. The Examiner agreed that Johansson fails to teach or suggest this feature of Applicants' recited invention.

Applicants' agent also pointed out that Johansson fails to teach or suggest "applying an implantation mask and patterning in such a way that an opening remains in a region provided for a later extrinsic base". The mask 13 of Johansson is not the same as Applicants' recited implantation mask, and the window 15 in the mask 13 of Johansson is not the same, or located in

the same place, as Applicants' recited remaining opening. The Examiner agreed that Johansson fails to teach or suggest this feature of Applicants' recited invention. However, the Examiner requested that the drawings be amended to show Applicants' recited implantation mask to clarify the distinction between Applicants' claim 16 and Johansson.

The Examiner also suggested amending claim 16 to recite that the emitter is already present during the application of implantation mask. However, Applicants' agent expressed concerns that such an amendment is unnecessary in view of the above-mentioned patentable distinctions.

Amendments to the drawings

Fig. 5 has been amended to show the implantation mask R and openings S. Support for this amendment can be found in original claim 1 and page 10, line 34 to page 11, line 5 of the originally-filed specification. No new matter has been introduced.

Amendments to the specification

The specification has been amended to provide reference characters for the implantation mask R and the opening S now shown in amended Fig. 5. No new matter has been introduced.

Rejection of claims 16-21, 23, 24, 26 and 28 under 35 U.S.C. §102(b)

The Office Action states that Johansson teaches all of Applicants' recited elements.

Independent claim 16 recites a method for the production of a bipolar transistor that includes a highly doped extrinsic base. Applicants' recited method includes, inter alia, "applying an implantation mask and patterning in such a way that an opening remains in a region provided

for a later extrinsic base", "introducing BF_2 as a dopant of a first conductivity type into the dielectric layer after the application of the mask", and "indiffusing, in a controlled thermal step, the dopant into the semiconductor substrate from the dielectric layer, an extrinsic base doped in low-resistance fashion arising", which Johansson fails to teach or suggest.

According to Applicants' recited invention, a dielectric layer DS is deposited directly onto a base layer BS (see Fig. 3). The dielectric layer DS is subsequently patterned and an emitter window EF is opened. Over the window, an emitter layer heavily doped with a dopant of a second conductivity type (e.g., arsenic) is then applied. The emitter layer is subsequently patterned with the aid of a photoresist mask resulting in an emitter E (see Fig. 4).

An implantation mask R is next applied for the purpose of introducing a dopant (e.g., BF_2) into the dielectric layer DS. The implantation mask R has openings S at the locations into which the dopant is to be subsequently introduced (indicated by the arrows I) (see Fig. 5 and paragraph [0036] of Applicants' published specification).

The dopant (e.g., BF_2) is transferred from the dielectric layer DS into the base layer BS by setting the desired diffusion conditions. The outdiffusion of boron from the dielectric layer DS into the underlying section of the base layer BS is effected at normal pressure under inert conditions. In this way, a highly doped extrinsic base is obtained, while the intrinsic base retains its original doping. At the same time as the diffusion of the boron from the dielectric layer, dopants of the second conductivity type also diffuse from the emitter into the base layer BS.

As a result of the entire diffusion operation, the base layer is highly doped and thus acquires low resistance in the region of the extrinsic base EB. The intrinsic base IB, which provides the actual base function in the bipolar transistor, is left in the remaining predominantly monocrystalline region of the base layer BS. The intrinsic (active) base IB is electrically

connected via the extrinsic base EB, which, as a result of the high doping, ensures a high conductivity and thus a low-resistance base terminal.

The finished bipolar transistor includes contacts for the connection of the individual transistor layers. Directly above the emitter E, an emitter contact EK is produced. In the region of the extrinsic base EB (i.e., the opening S of the mask R), above the base layer in the dielectric layer DS and the other layers optionally applied thereabove, in a window, the base layer BS is uncovered and the base contact BK is applied. The contact to the collector is implemented outside the transistor region.

Johansson discloses a method for forming base regions and for opening an emitter window in a silicon bipolar transistor. According to Johansson, a silicon substrate is provided with suitable device isolation. A first base region is formed in, or on top of, the substrate. A thin layer of oxide is formed on the first base region. A layer of silicon is formed on top of the thin oxide layer. The silicon layer of Johansson is a second base region and is ion implanted. A layer of a dielectric is formed on top of the silicon layer and isolates the base and emitter regions of the transistor. The structure of Johansson is patterned to define the emitter window. The structure inside the defined emitter window area is etched and the thin oxide layer is used as etch stop, thus forming the emitter window. The structure of Johansson is then heated to break up the oxide layer such that the first and second base regions contact each other.

The Examiner cites col. 4, lines 41-43 and Fig. 7 of Johansson as teaching Applicants' recited step of applying an implantation mask and patterning in such a way that an opening remains in a region provided for a later extrinsic base. Applicants disagree.

Johansson describes only a photoresist mask 13 (see Fig. 7 of Johansson). The photoresist mask of Johansson includes a central opening 15 provided for the production of the emitter

window in the amorphous silicon layer (α-Si) 9 and in the oxide layer 11, which is applied on the amorphous silicon layer 9. Both layers of the photoresist mask of Johansson cover the entire surface of silicon dioxide layer 7.

Consequently, Johansson fails to teach or suggest a mask that includes an additional opening provided for an extrinsic base. This is in stark contrast to the device recited in Applicants' claim 16, which requires "applying an implantation mask and patterning in such a way that an opening remains in a region provided for a later extrinsic base".

The Examiner cites col. 4, lines 25-34 and Fig. 5 of Johansson as teaching Applicants' recited step of introducing BF_2 as a dopant of a first conductivity type into the dielectric layer after the application of the mask.

Johansson discloses implantation of BF_2 into the whole surface of the amorphous silicon layer 9 (see Fig. 5 of Johansson). The structure of Johansson is then covered by a PETEOS layer 11 (see Fig. 6 of Johansson). Then, a photomask 13 is applied to the layer 11 (see Fig. 7 of Johansson). In other words, in Johansson implantation of BF_2 takes place before the production of the only photomask 13 (see Fig. 4 of Johansson). Although this implantation is provided for the production of the extrinsic base, the necessary structuring of the implanted region is effected only afterwards by a removal of the layers in the area of the emitter window.

As described above, Applicants' recited implantation mask R is applied first. Then the BF_2 is introduced into the dielectric layer DS, as shown in Figs. 4 and 5 of Applicants' published specification. Therefore, Johansson clearly fails to teach or suggest "introducing BF_2 as a dopant of a first conductivity type into the dielectric layer after the application of the mask", as recited in Applicants' claim 16.

Further, Johansson discloses implantation of BF_2 into the amorphous silicon (α-Si) layer 9. According to Johansson, "[t]he energy is selected so that all of the Boron ions will be contained within the α-Si" (see col. 4, lines 28-29 of Johansson). Therefore, BF_2 is expressly not intended to be implanted into the dielectric silicon dioxide layer 7, which is under the amorphous silicon. Further, the upper dielectric layer 11 is not yet present in this state of the process of Johansson.

Therefore, Johansson again fails to teach or suggest "introducing BF_2 as a dopant of a first conductivity type into the dielectric layer after the application of the mask", as recited in Applicants' claim 16.

The Examiner cites col. 4, lines 25-34 and Fig. 5 of Johansson as teaching Applicants' recited step of indiffusing, in a controlled thermal step, the dopant into the semiconductor substrate from the dielectric layer, an extrinsic base doped in low-resistance fashion arising. Applicants disagree.

Johansson discloses that in a later thermal annealing process, which also drives dopants out of the emitter, the oxide will break up and the two silicon layers 5 and 9 will contact each other and form a thick, highly doped silicon layer for the extrinsic base (see col. 4, lines 24-34 of Johansson). The question of whether a diffusion of dopants from the upper silicon layer 9 into the lower silicon layer 5 participates in this process is not discussed.

However, Johansson mentions that, apart from using an ion implantation, the silicon layer 5 can be applied already highly doped, so that a subsequent diffusion of dopant into the silicon layer 5 is not necessary (see col. 3, lines 60-63 of Johansson). Hence, diffusion from a dielectric layer into semiconductor material is not necessary and is consequently not provided.

Therefore, Johansson fails to teach or suggest "indiffusing, in a controlled thermal step,

the dopant into the semiconductor substrate from the dielectric layer, an extrinsic base doped in low-resistance fashion arising", as recited in Applicants' claim 16.

In view of the foregoing, Applicants' submit that Johansson fails to teach or suggest the subject matter recited in independent claim 16. Accordingly, claim 16 is patentable over Johansson under 35 U.S.C. §102(b).

Claims 17-21, 23, 24, 26, and 28, which depend from independent claim 16, incorporate all of the limitations of independent claim 16 and are, therefore, deemed to be patentably distinct over Johansson for at least those reasons discussed above with respect to independent claim 16.

Rejection of claims 22, 25, 27, and 29 under 35 U.S.C. §103(a)

The Office Action states that the combination of Johansson and Johnson teaches all of the elements recited in Applicants' claims.

Johansson has been previously discussed and fails to teach or suggest the invention recited in Applicants' independent claim 16.

Because Johansson fails to teach or suggest the subject matter recited in Applicants' independent claim 16, and because Johnson fails to teach or suggest any elements of independent claim 16 that Johansson is missing, the addition of Johnson to the reference combination fails to remedy the above-described deficiencies of Johansson.

Claim 22, 25, 27, and 29, which depend from independent claim 16, incorporate all of the limitations of independent claim 16 and are therefore deemed to be patentably distinct over Johansson and Johnson for at least those reasons discussed above for independent claim 16.

Conclusion

In view of the foregoing, reconsideration and withdrawal of all rejections, and allowance of all pending claims is respectfully solicited.

Should the Examiner have any comments, questions, suggestions, or objections, the Examiner is respectfully requested to telephone the undersigned in order to facilitate reaching a resolution of any outstanding issues.

Respectfully submitted,
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